9.5

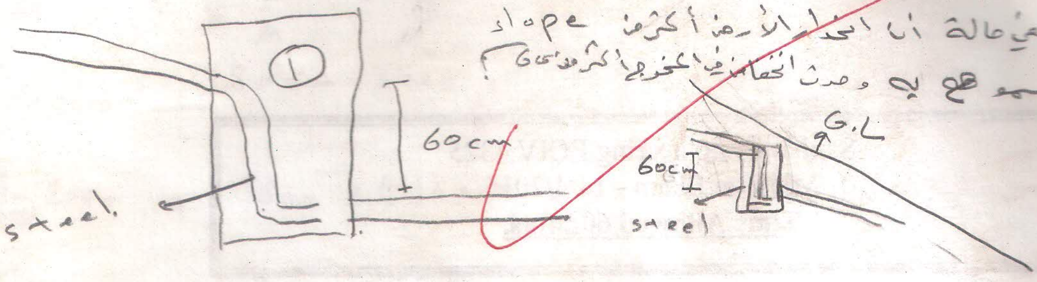
Problem No. 1 (10 Points)

Answer the following questions:

a. Determine –with neat sketch– in which case we need to construct drop manholes?

ا- نحتاج لـ drop manhole في حين يكون مستوى inlet يختلف عن مستوى outlet أكثر من 60

٢- وفي حالة أن انحدار الأرض أكثر من slope المسموح به وحدث انخفاض في الخروج أكثر من 60 ؟



b. What are the upper and lower limits of pipe slope? and explain why these limits required?

أكبر قيمة ٣٪ وهنا حتى لا تكون هنالك سرعات عالية تؤدي إلى إتلاف في pipe وذلك في حالات Q_p

أصغر قيمة ٠.٤٪ وهنا حتى لا يسمح بترسيب وحدوث ترسيب في الـ pipe في حالة Q_{min}

c. If the inverted siphon consists of three pipes, what is flow rate in each pipe (without calculations)? what is the minimum required velocity in each pipe? and why this velocity is larger than the velocity in partial flow pipe?

$Q_1 = Q_{min} = Q_{ave} * M_f$

$Q_2 = Q_{ave} - Q_{min}$

$Q_3 = Q_{Des} - Q_{ave}$

$Q_{ave} \times P_f$

Pressure means Pump??

$-\frac{1}{2}$

أقل سرعة مسموح بها هو 0.9m وذلك لأنه هنا الأنابيب تنقل flow تحت مبدأ الضغط وليس الجاذبية ويكون هناك loss فنحتاج سرعة عالية حتى تعوض عن loss.

d. If the applied stress on the pipe exceeds the maximum allowable strength of the pipe, **suggest at least 2 solutions** to overcome this problem.

١- زيادة قطر pipe .

٢- زيادة الـ min cover الخاصة بالـ pipe .

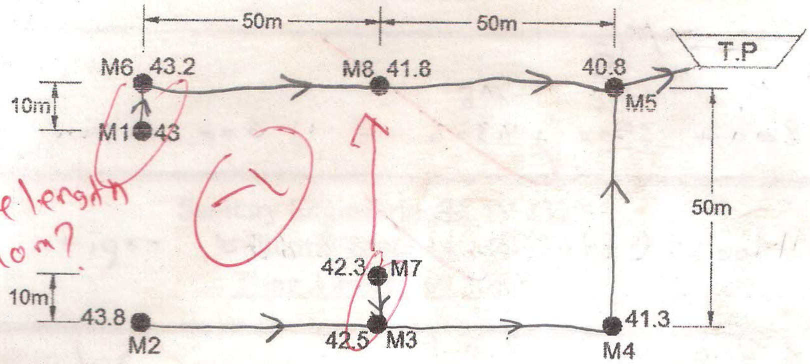
٣- لو كان هذا في منطقة معينة على الـ pipe ممكن أن أقوم بعملية تقوية للـ pipe عن طريق صب باطون على pipe نفسه في هذه المنطقة فقط

٤- زيادة سمك pipe والمحافظة على القطر .

٥- تغيير المنطقة ووضعه مثلا في جانب الطريق .

Problem No. 2 (15 Points)

The manholes of a waste water collection network of a small city are shown in the figure below with ground level at each manhole.



If the following data are given:

- The population served by each manhole alone (**not cumulative**) at a year of 2015 are shown in the following table:

Manhole	Served Population (capita)	served population 2050
M1	3800	
M2	4300	
M3	3300	
M4	4300	
M5	3900	
M6	3500	
M7	3800	
M8	4300	

- Design year is 2050, growth rate is 3.5% and average water consumption is 150 L/c/d.
- Manning Coefficient = 0.013, commercial pipes are: 8", 10",….20" (2 steps)
- Use common design criteria.

Required:

1. Connect between the existing manholes by appropriate pipes and then locate the flow directions through these pipes in order to drain in the shown treatment plant. → انظر عرض الحل سابقاً
2. ~~Design the connecting pipe between manholes M5 and M8.~~
3. If this pipe (pipe in the previous required) has a diameter of 16'', thickness of 5cm and the minimum required soil cover above the pipe is 1.5 m, calculate the depth of excavation at the upstream and downstream manholes of this pipe.
4. In design phase, if the partial flow velocity (V_P) is less than 0.6 m/s, suggest 2 solutions (without calculations) to overcome this problem.

(1) The solution behind in same draw

(2) $M_8 \longrightarrow M_5$

$$P_{@2015} = \underset{M_1}{3800} + \underset{M_6}{3500} + \underset{M_8}{4300} = 11600 \text{ capita}$$

$$P_{@2050} = 11600 \times (1+0.035)^{35} = 38670 \text{ capita}$$

$$Q_{ave} = \frac{38670 \times 150 \times 0.8}{1000 \times 3600 \times 24} = 0.053 \ m^3/s$$

$$P_f = 1 + \frac{14}{4+\sqrt{38.67}} = 2.37$$

$$Q_p = 2.37 \times 0.053 = 0.126 \ m^3/s$$

suppos $\frac{d}{D} = 0.67 \Longrightarrow$ fromchart $\frac{Q_p}{Q_f} = 0.785$

$$Q_f = \frac{0.126}{0.785} = 0.16 \ m^3/s$$

$$Q_{min} = 0.053 \times 0.2 \times 38.67^{1/6} = 0.019 \ m^3/s$$

$$S = \frac{41.8 - 40.8}{50} = 0.02$$

$$0.16 = \frac{0.312}{0.013} D^{8/3} \ 0.02^{0.5}$$

$$D = 0.32 \ m$$

$$D = \frac{0.322}{2.54} = 12.6 \text{ in} \Longrightarrow 14 \text{ in}$$

$$D_{new}(m) = 14 \times 2.54 = 35.56 \text{ cm}$$

$$Q_{f_{new}} = \frac{0.312}{0.013} \; 0.3556^{8/3} \times 0.02^{0.5}$$

$$= 0.215 \; m^3/s$$

$$\frac{Q_p}{Q_f} = \frac{0.126}{0.215} = 0.58 \Longrightarrow \text{from chart } \frac{d}{D} = 0.55$$

$$\text{from chart } \frac{V_p}{V_f} = 1.03$$

$$V_f = \frac{1}{0.013} \times \left(\frac{0.3556}{4}\right)^{2/3} \times 0.02^{0.5} = 2.16 \; m^3/s$$

$$V_p = 1.03 \times 2.16 = 2.231$$

check slope

$S = 0.02 < 0.03$ ok.

$= 0.02 > 0.005$ ok

check v_p, v_f

$0.5 m/s < v_p, v_f < 3 m/s$ ok

$$\frac{Q_{min}}{Q_{full}} = \frac{0.019}{0.215} = 0.08$$

$$\text{from chart } \frac{V_p}{V_f} = 0.58$$

$V_{p_{min}} = 0.58 \times 2.16 = 1.25 m/s$

check

$V_{min} > 0.6$ ok

< 3 ok

(3) upper manhole depth excavation $= 1.5 + 0.05 + 0.406 + 0.05$

$= 2.006$ m

down stream depth of excavation (1+h) $= 2.006 + 0.02 \times 50 = 3.006$ m

actual downstream excavation $= 3.006 - (41.8 - 40.8) = 2.006$ m

so $d_{upper} = 2.006$ m

$d_{down} = 2.006$ m 5

أحمد في الخلف

Useful Formulas

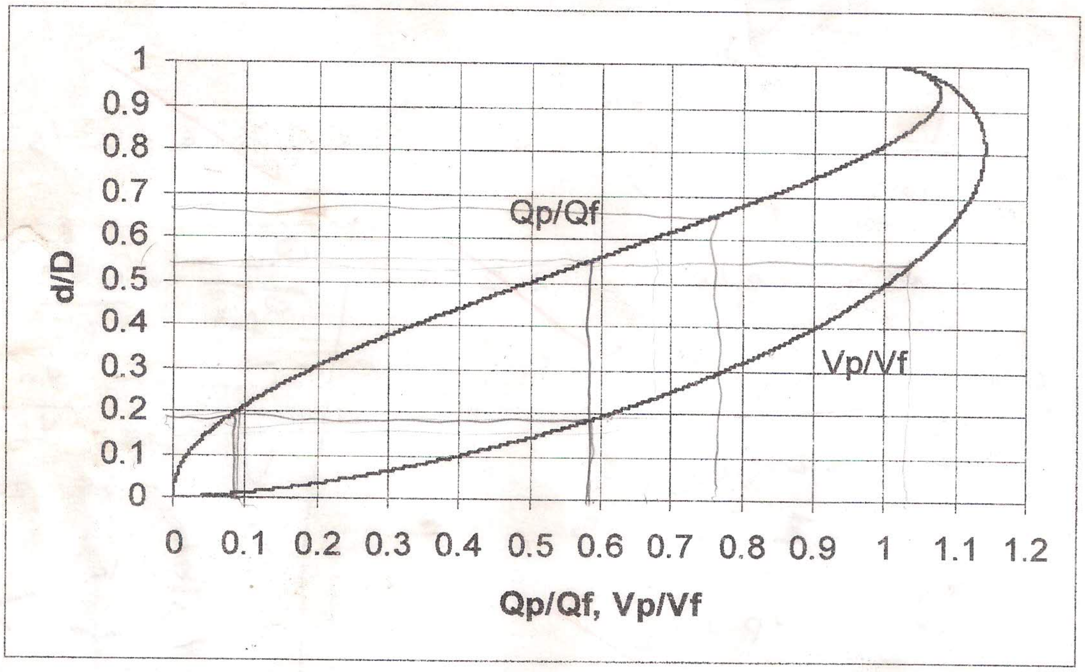
$$V_f = \frac{1}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$$

$$Q_f = \frac{0.312}{n} D^{\frac{8}{3}} S^{\frac{1}{2}}$$

$$P_t = P_0 (1+k)^n$$

$$P_f = 1 + \frac{14}{4+\sqrt{P}}$$

$$M_f = 0.20 \times P^{\frac{1}{6}}$$



(4)

١- زيادة slope .

٢- تكبير المقطع